

Additively Manufactured Metals in Oxygen Systems Project

Center Independent Research & Developments: JSC IRAD Program | Mission Support Directorate (MSD)



ABSTRACT

Metals produced by additive manufacturing methods, such as Powder Bed Fusion Technology, are now mature enough to be considered for qualification in human spaceflight oxygen systems. The mechanical properties of metals produced through AM processes are being systematically studied. However, it is unknown whether AM metals in oxygen applications may present an increased risk of flammability or ignition as compared to wrought metals of the same metallurgical composition due to increased porosity. Per NASA-STD-6001B materials to be used in oxygen system applications shall be based on flammability and combustion test data, followed by a flammability assessment. Without systematic flammability and ignition testing in oxygen there is no credible method for NASA to accurately evaluate the risk of using AM metals in oxygen systems.

ANTICIPATED BENEFITS

To NASA funded missions:

Space Launch System has published intent to use additively manufactured (AM) components in human spaceflight oxygen systems. This project will help engineers better understand the risks of using printed metals in oxygen systems.

To the commercial space industry:

Commercial Crew Program partners have published intent to use additively manufactured (AM) components in human spaceflight oxygen systems. This project will help engineers better understand the risks of using printed metals in oxygen systems.

DETAILED DESCRIPTION

One of the technology areas outlined in the Evolvable Mars Campaign is "Spacecraft Assembly and Maintenance". As space exploration becomes earth independent, technology needs to



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Management Team

Principal Investigator:

- Jonathan Tylka

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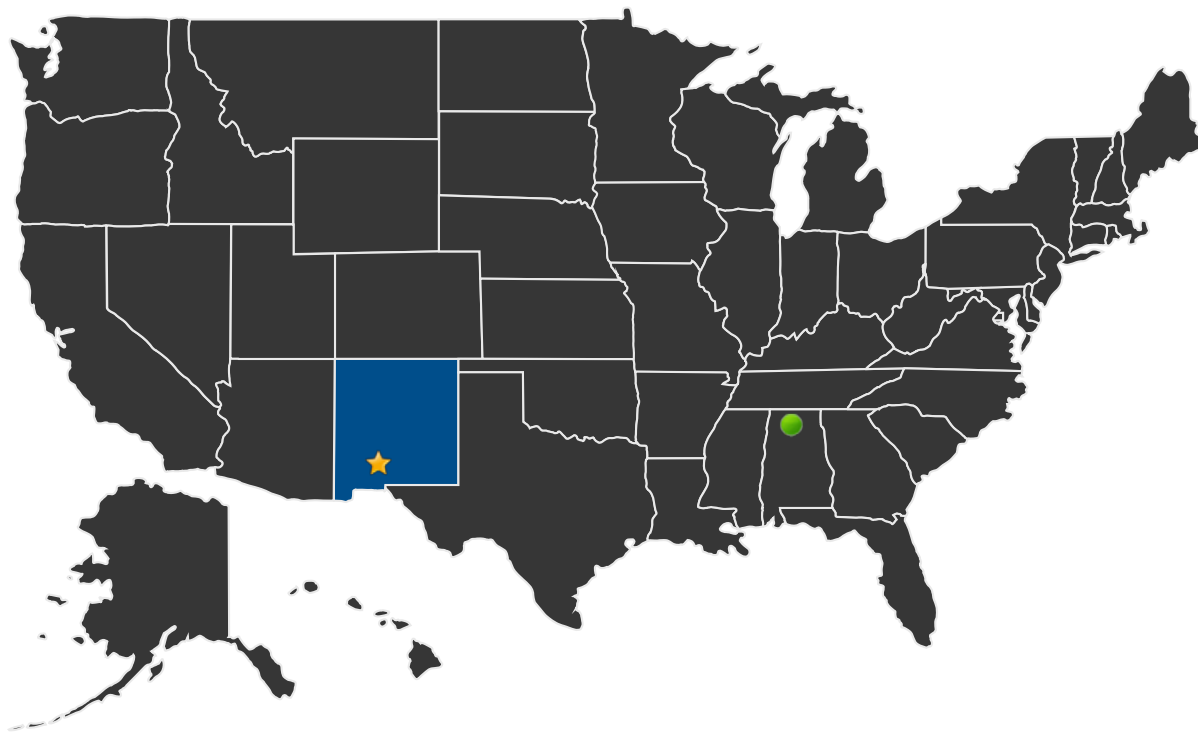
allow astronauts to perform “maintenance with only the parts and tools they carry or produce in-situ”. In-space maintenance will hinge upon the use of additive manufacturing technology due to its use of generic space storable material, and versatile production capability. In order to repair systems used to sustain life and mobility in space on an exploration mission, parts used in oxygen systems will need to be built and repaired in-situ. Parts produced by these types of additive manufacturing techniques have not been fully evaluated for use in oxygen systems and the inherent risks have not been fully identified. If an ignition were to occur printed metal could be more flammable than components manufactured from a traditional billet of wrought metal and present a significant hazard. NASA-STD-6001B Test 17 “Upward Flammability of Materials in Gaseous Oxygen” will be used to evaluate the flammability of Inconel 718 configured as a 1/8th inch diameter rods produced by three manufacturing processes at a single pressure: 1) Printed with no heat treatment 2) Printed and processed with a hot isostatic pressing method 3) Wrought. The samples internal porosity will be measured and compared with the material flammability results. MSFC will provide test samples as their contribution to this collaborative effort. If awarded with \$10,000 from the Innovation Charge Account Call WSTF would be able to perform promoted combustion tests on 30 rods to begin understanding effects of materials flammability associated with additive manufactured parts compared to historical flammability data on wrought Inconel 718. The product from WSTF flammability testing will be the publication of a report outlining the initial flammability performance results from pre/post processed AM Inconel 718 compared to wrought Inconel 718. The flammability data will also contribute to NASA flammability databases used in oxygen compatibility assessments. Going forward WSTF will be seeking funding from the Office of Safety and Mission Assurance, NASA Engineering and Safety Center, and future JSC Innovation Charge Account proposals to perform flammability and ignition testing on all AM metals seriously considered for use in oxygen systems. Fully characterizing AM metals in oxygen systems will provide NASA with a credible method to evaluate the risk of using AM metals in oxygen system applications through material and component compatibility assessment in liquid and gaseous oxygen environments.

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U.S. LOCATIONS WORKING ON THIS PROJECT



■ U.S. States With Work ★ **Lead Center:**
White Sands Test Facility

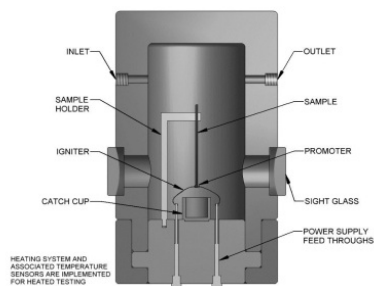
● **Supporting Centers:**
• Marshall Space Flight Center

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IMAGE GALLERY



Cross-section of representative upward flammability test apparatus